



*Supplement of*

## **Blowing snow contributions to the Arctic snow-on-sea ice budget using ICESat-2 observations**

**Joseph Robinson et al.**

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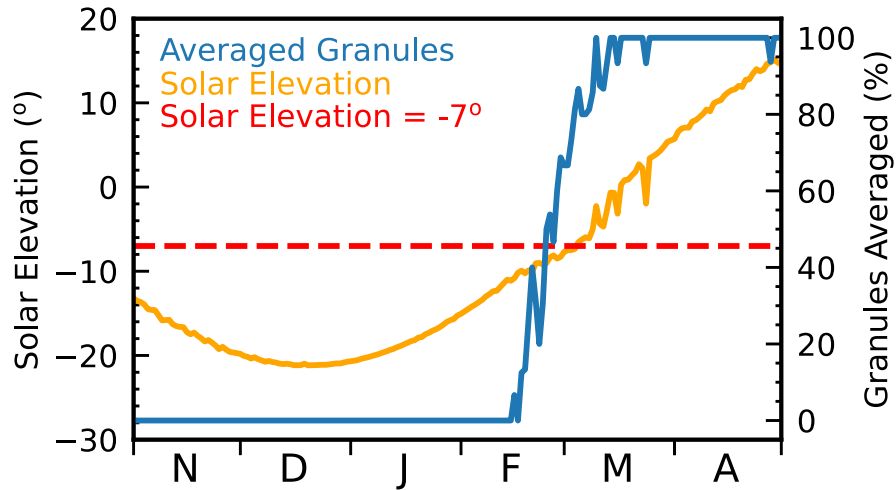
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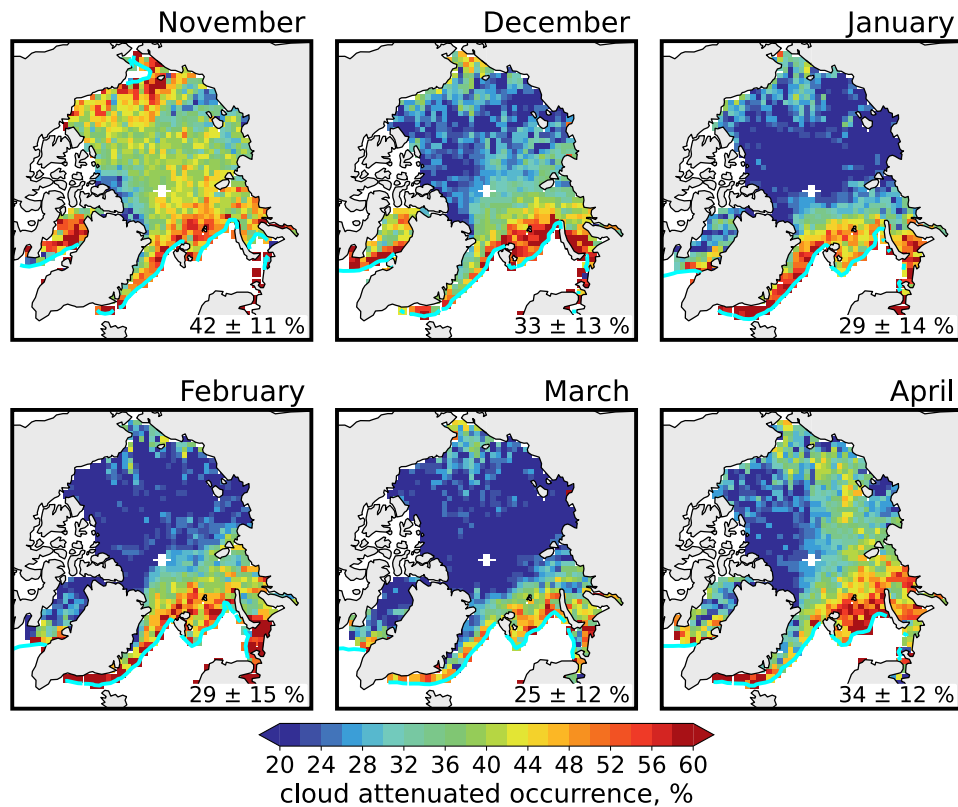
Figures S1 to S10

### **Introduction**

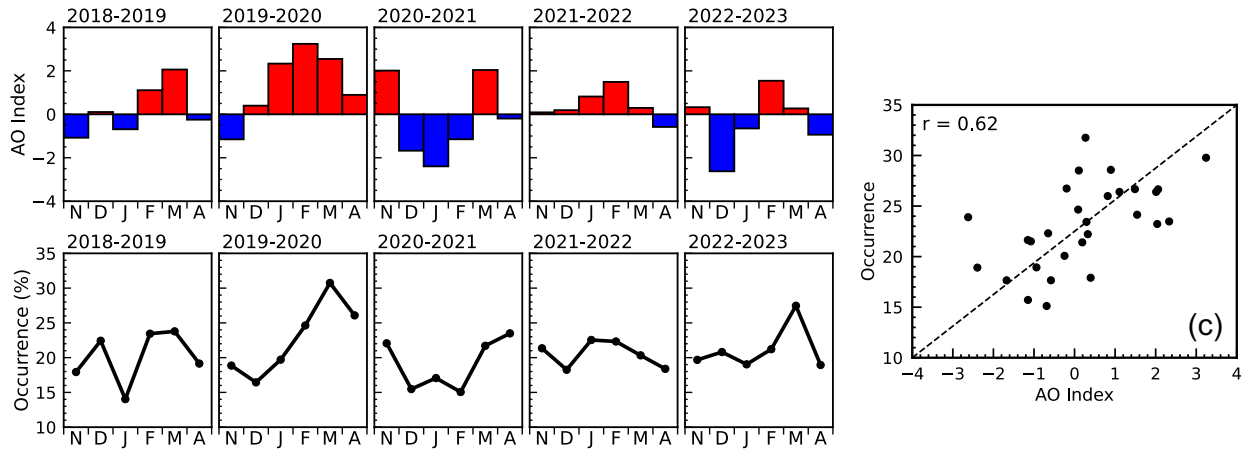
The included support information provides additional figures contextualizing the main text, including smoothing of ICESat-2 observations to increase signal-to-noise (Figure S1) and the relative occurrence frequency of cloud attenuation as observed by ICESat-2 (Figure S2). The timeseries of monthly Arctic Oscillation (AO) index and ICESat-2 derived blowing snow occurrence is shown in Figure S3. Figure S4 shows 5-day rolling timeseries of the percent of all sea ice covered by each ICESat-2 grid cell label (blowing snow, mixed, clear air, cloud attenuated; see Section 2.5 of the main text). Figure S5 shows the spatial distribution of seasonal mean ICESat-2 and SnowModel-LG blowing snow burdens (mass per square meter). Figure S6 shows the interannual spatial variability in ICESat-2 inferred blowing snow divergence. Meteorological conditions averaged across all (the 2021-2022) cold seasons are shown in Figure S7 (Figure S8). Figure S9 shows the daily amount of snowfall offset by blowing snow sublimation and Figure S10 shows the 2018-2023 mean blowing snow sublimation predicted by SnowModel-LG and DY2001 under all conditions (regardless of ICESat-2 data availability).



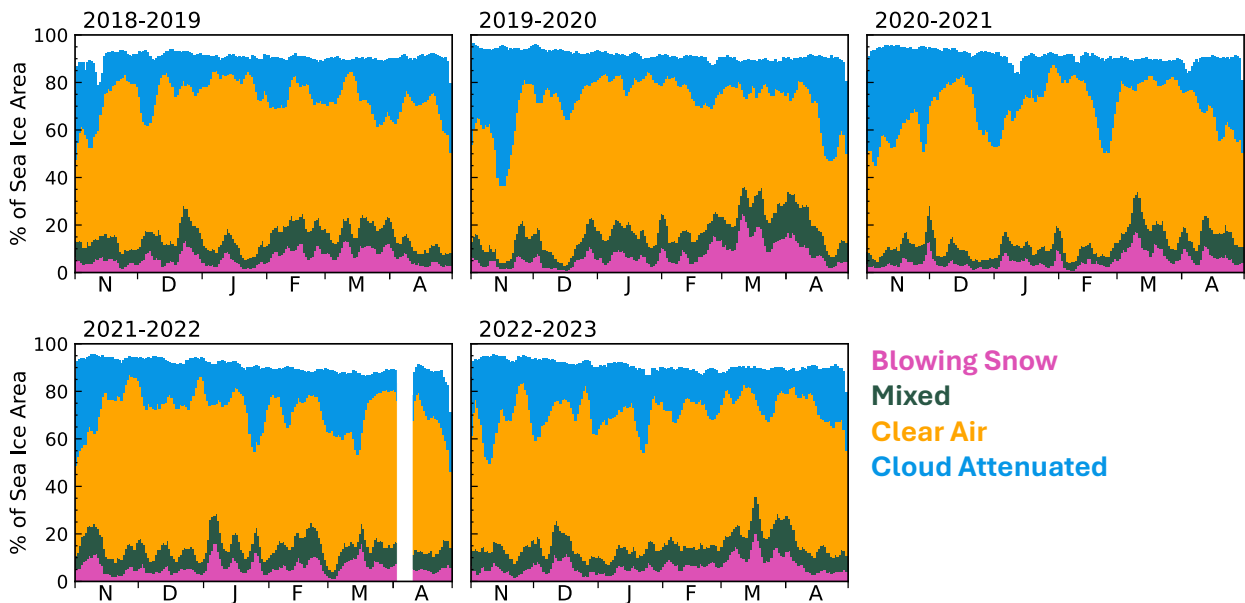
**Figure S1.** Characteristic cold season timeseries on the statistics of ICESat-2 data averaging from the native 280 m to 7 km along track. The average solar elevation is given in orange with the  $-7^\circ$  cutoff shown as a red dashed line. The blue line shows the percent of ICESat-2 granules that are horizontally averaged.



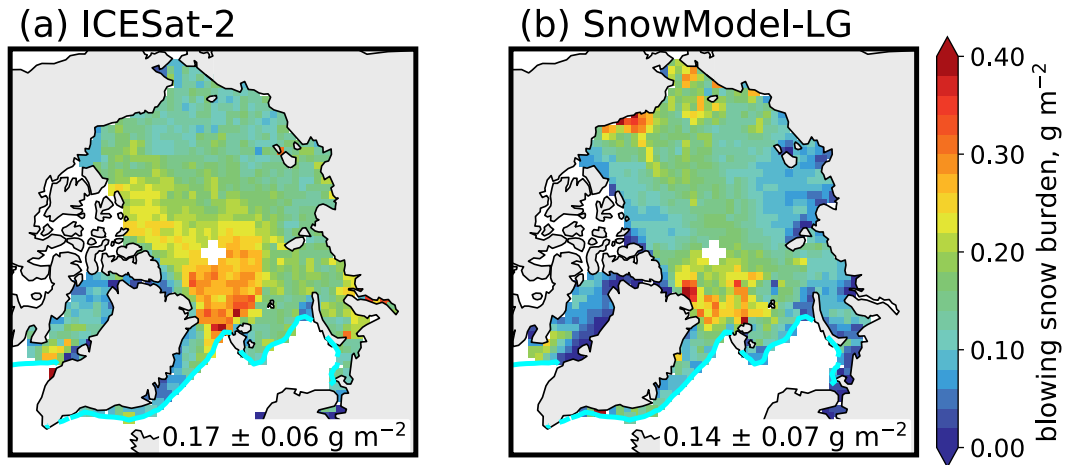
**Figure S2.** Monthly averaged cloud attenuated occurrence observed by ICESat-2 over the 2018-2023 cold seasons. The shading represents the percent of all ICESat-2 profiles in each grid box for which the surface could not be observed.



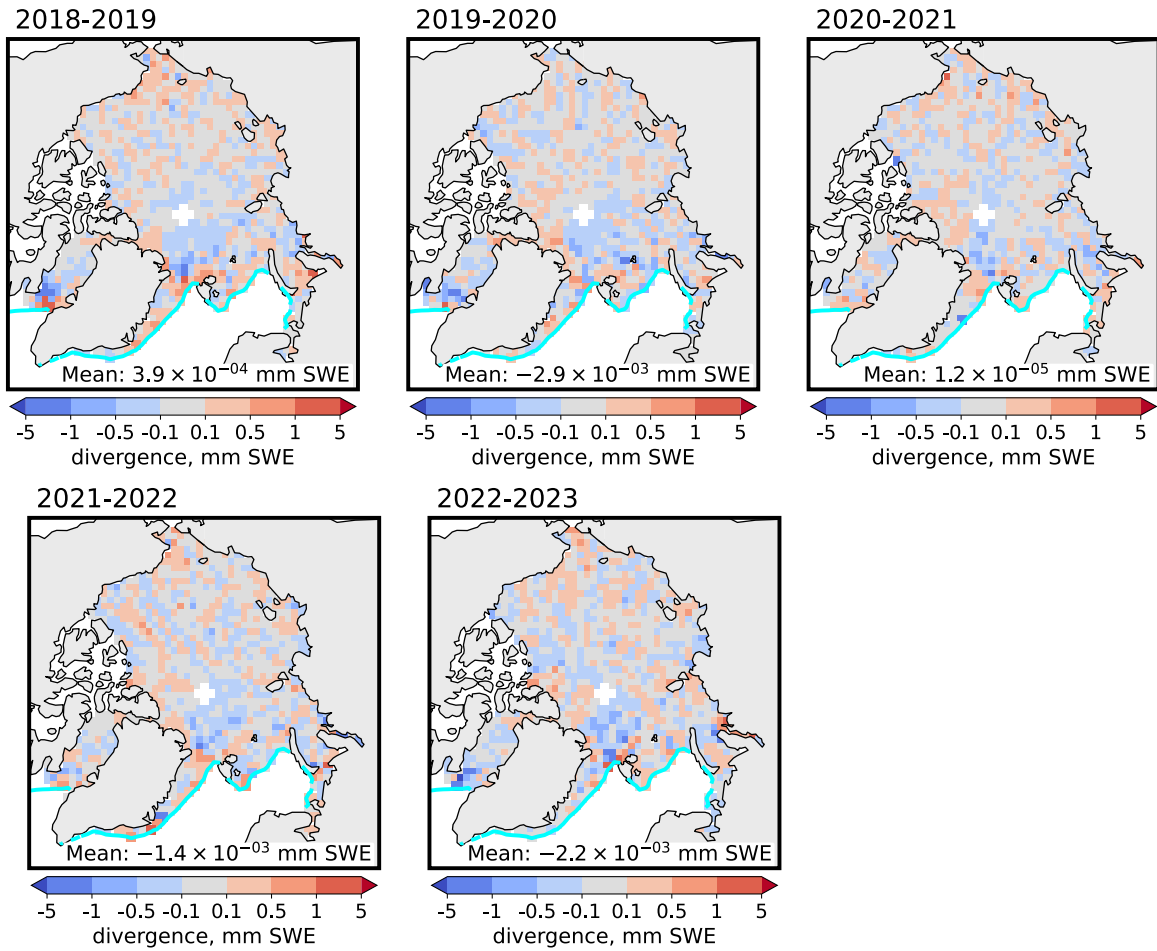
**Figure S3. (top row)** Monthly timeseries of the Arctic Oscillation index for the 2018-2023 cold seasons (accessed at [http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily\\_ao\\_index/monthly.ao.index.b50.current.ascii](http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/monthly.ao.index.b50.current.ascii)). **(bottom row)** Monthly timeseries of ICESat-2 derived blowing snow occurrence for the 2018-2023 cold seasons. **(c)** Correlation between monthly AO index (x-axis) and ICESat-2 monthly mean pan-Arctic blowing snow occurrence frequency (y-axis).



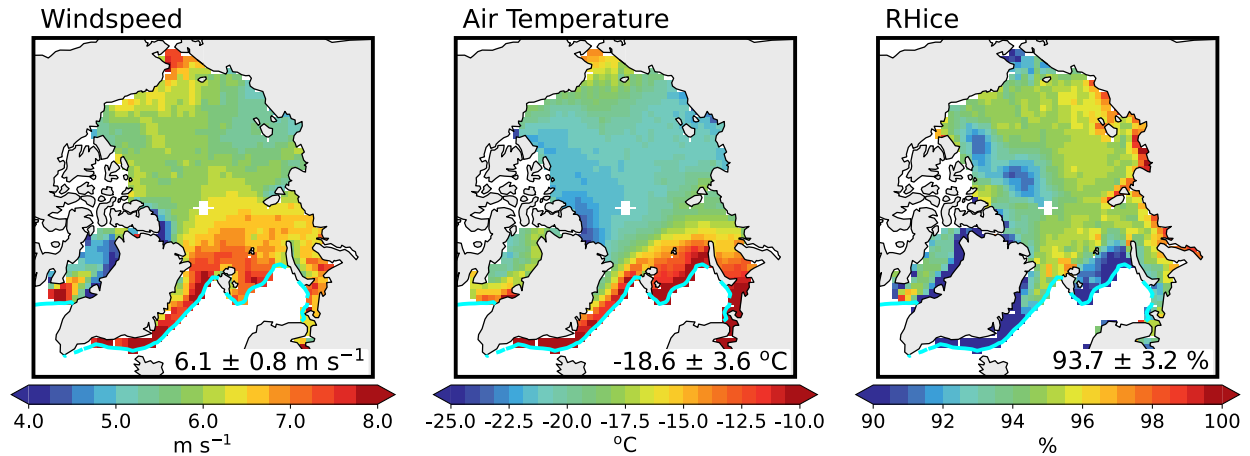
**Figure S4.** Timeseries of ICESat-2 observed grid cell labeled areas (in % of total sea ice area poleward of 65° N) for each individual cold season. The labelling is done using a 5-day running average of ICESat-2 profiles and each grid cell is labeled as blowing snow (magenta), mixed (green), clear air (orange), or cloud attenuated (blue) as described in Section 2.5.



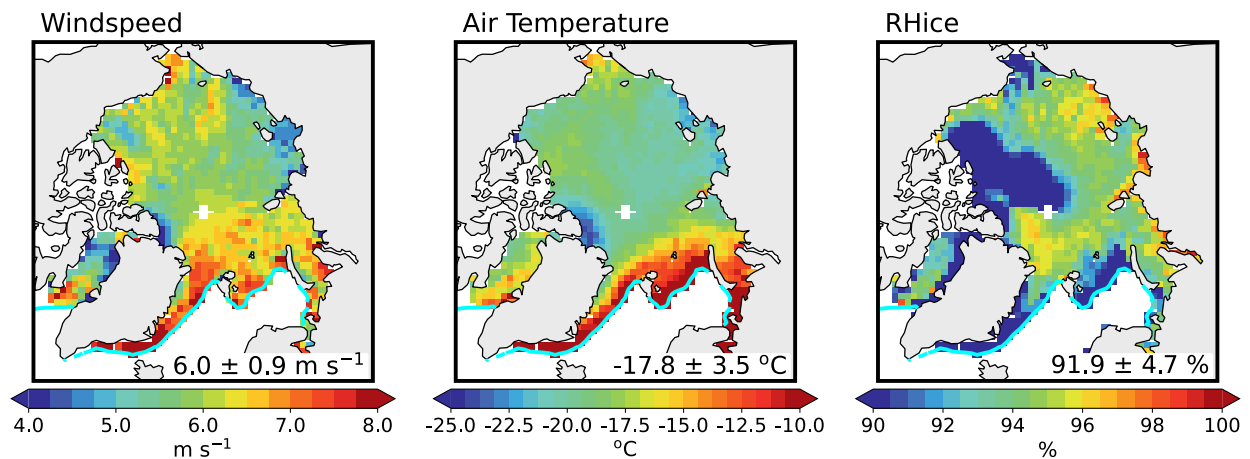
**Figure S5.** Seasonally averaged blowing snow mass burdens (units  $\text{g m}^{-2}$ ) over the 2018-2023 cold seasons from **(a)** ICESat-2 and **(b)** SnowModel-LG. Mass burdens are calculated by vertically integrating blowing snow mass concentration ( $\text{g m}^{-3}$ ) over the depth of the blowing snow layer.



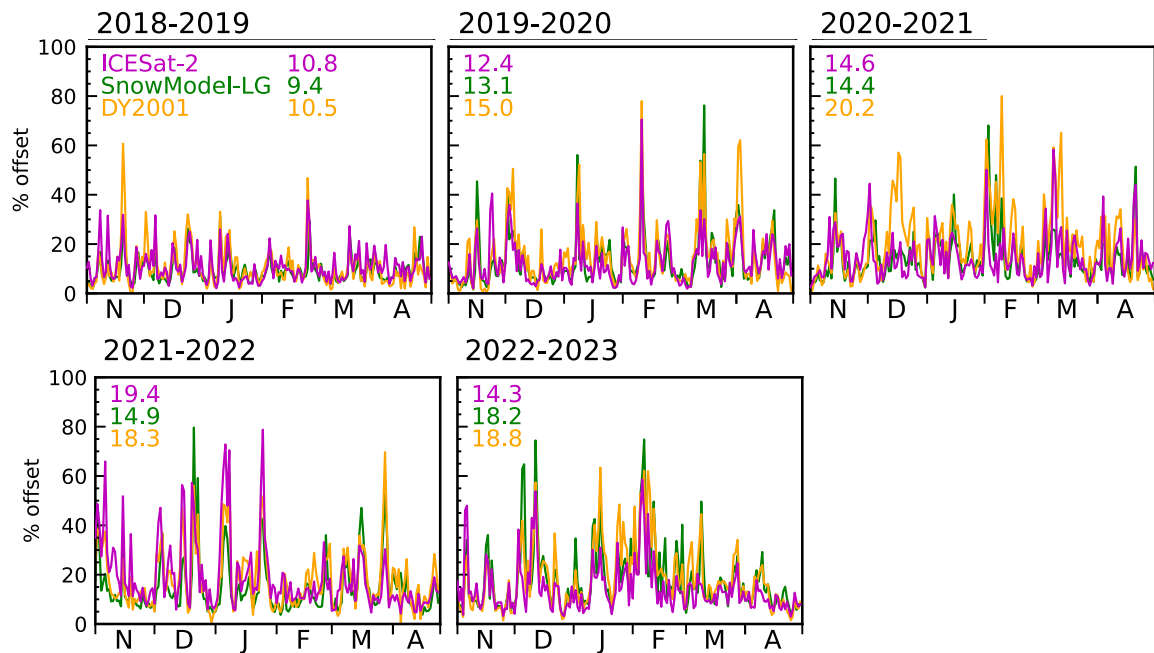
**Fig S6.** Interannual spatial variability of divergence in blowing snow transport (units mm SWE) inferred from ICESat-2 observations during the 2018-2023 cold seasons.



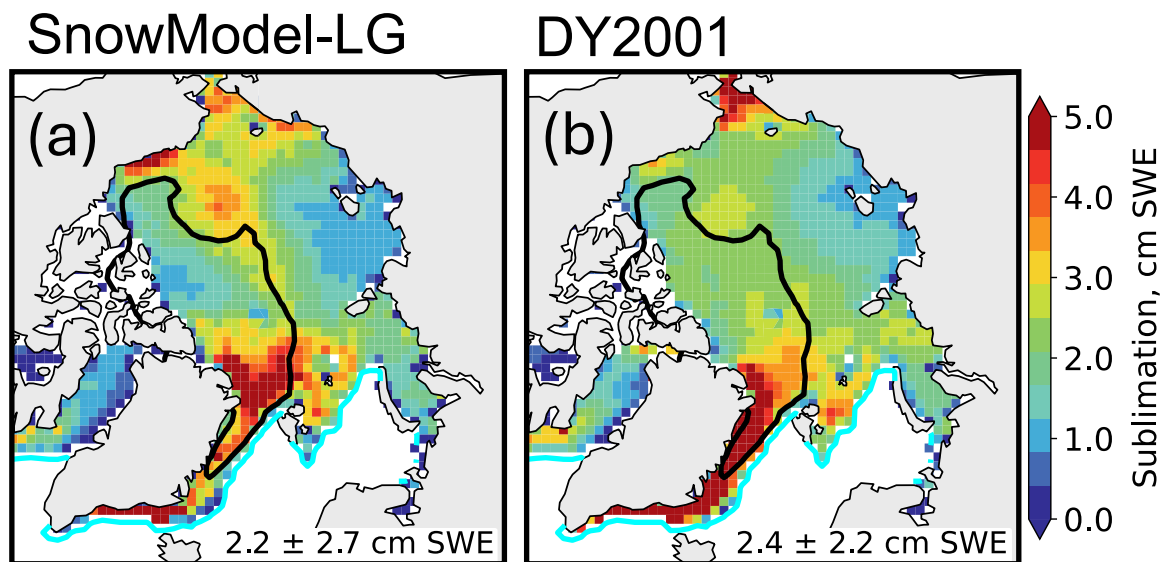
**Figure S7.** Seasonally averaged MERRA-2 meteorological conditions (10 m windspeed, 2 m air temperature, and 2 m relative humidity with respect to ice) over the 2018-2023 cold seasons. The fields are averaged regardless of whether ICESat-2 has available observations for a given grid cell on a given day.



**Figure S8.** Seasonally averaged MERRA-2 meteorological conditions (10 m windspeed, 2 m air temperature, and 2 m relative humidity with respect to ice) for the 2021-2022 cold season. The fields are averaged regardless of whether ICESat-2 has available observations for a given grid cell on a given day.



**Figure S9.** Timeseries of daily snowfall offset by blowing snow sublimation across the 2018-2023 Arctic cold seasons. Daily offsets (units %) are shown for ICESat-2 (magenta line), SnowModel-LG (green line), and DY2001 (orange line).



**Figure S10.** Spatial distribution of 2018-2023 all conditions blowing snow sublimation over Arctic sea ice predicted by (a) SnowModel-LG and (b) DY2001. All conditions means the SnowModel-LG and DY2001 results are analyzed regardless of whether ICESat-2 has available observations for a given grid cell on a given day. The bottom right of each panel shows the mean and standard deviation.